Developing Sustainable Bike Share Systems

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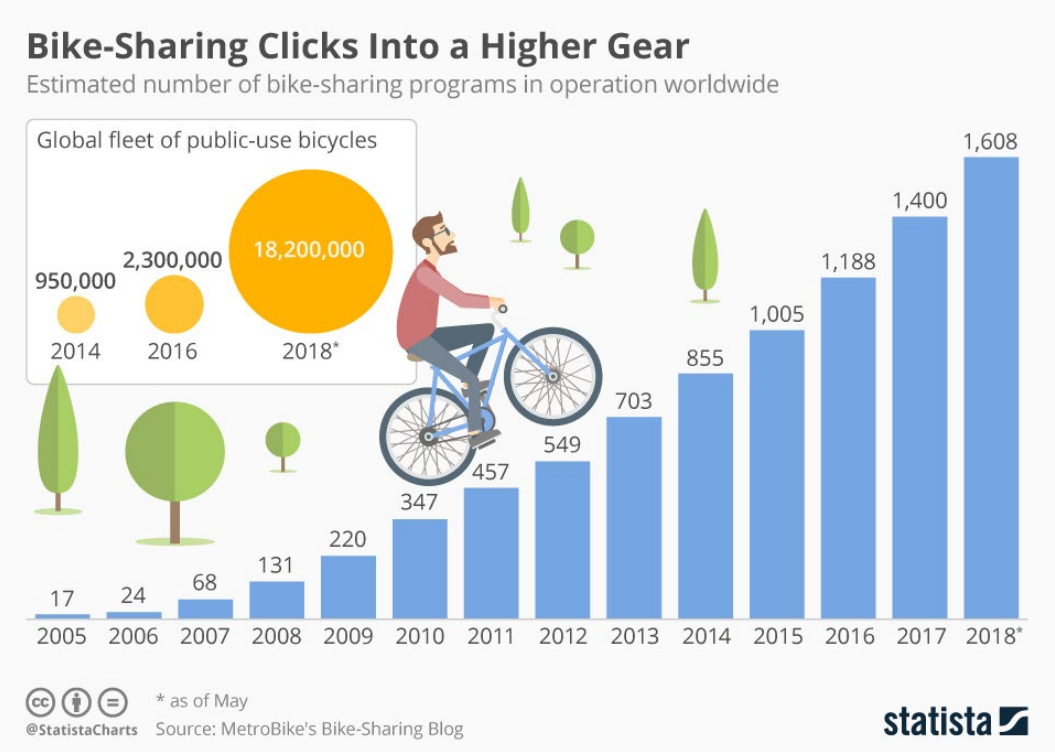
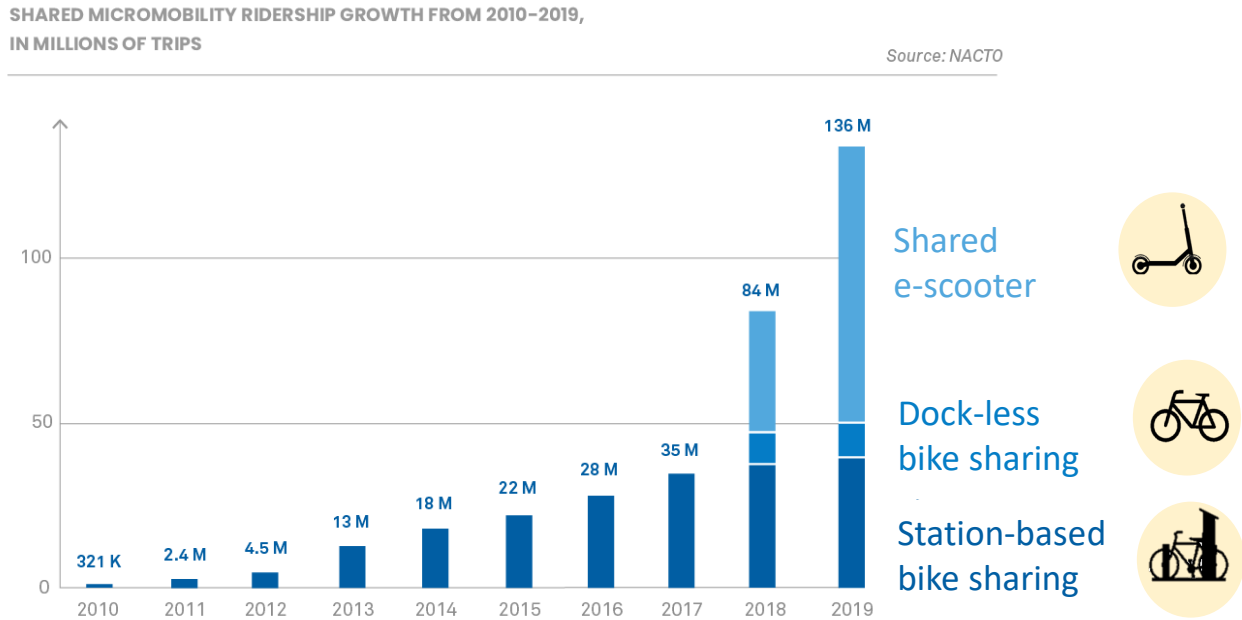
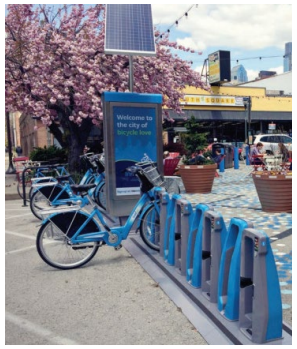
Bike share systems have been growing rapidly

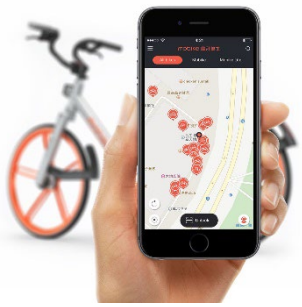


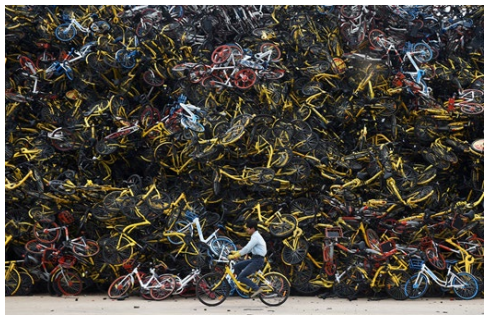


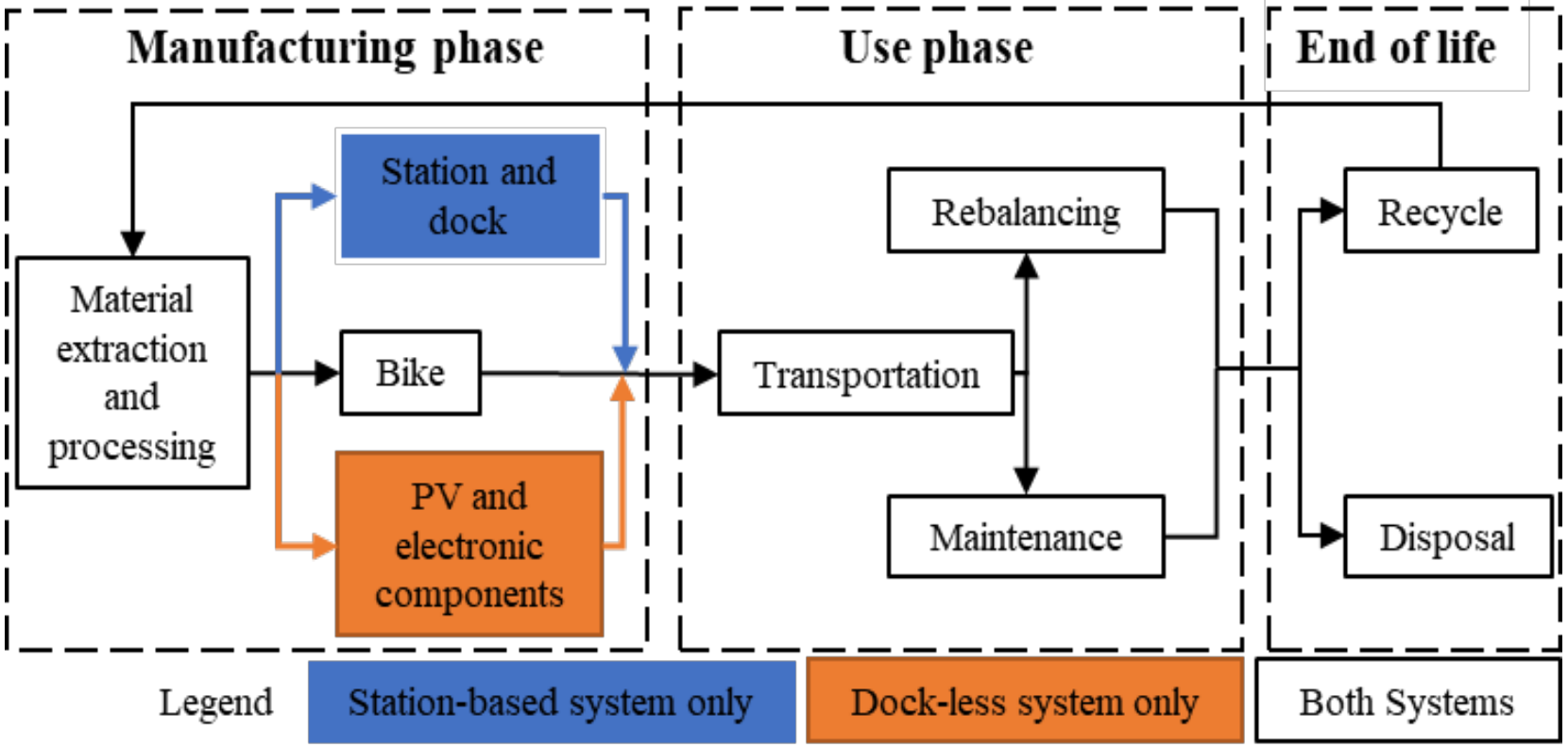
- Globally, bike share systems are developing rapidly
- In the U.S., 136 million trips are taken using shared micromobility in 2019
- The emerging shared dockless bikes, e-scooters, and e-bikes

The environmental benefits of bike share system need to be evaluated from the life-cycle perspective



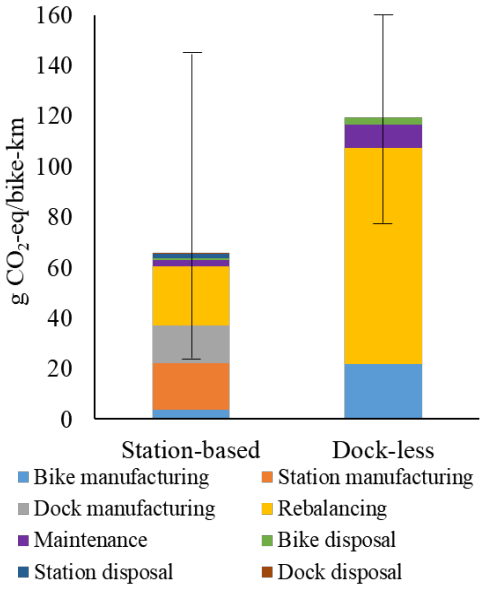


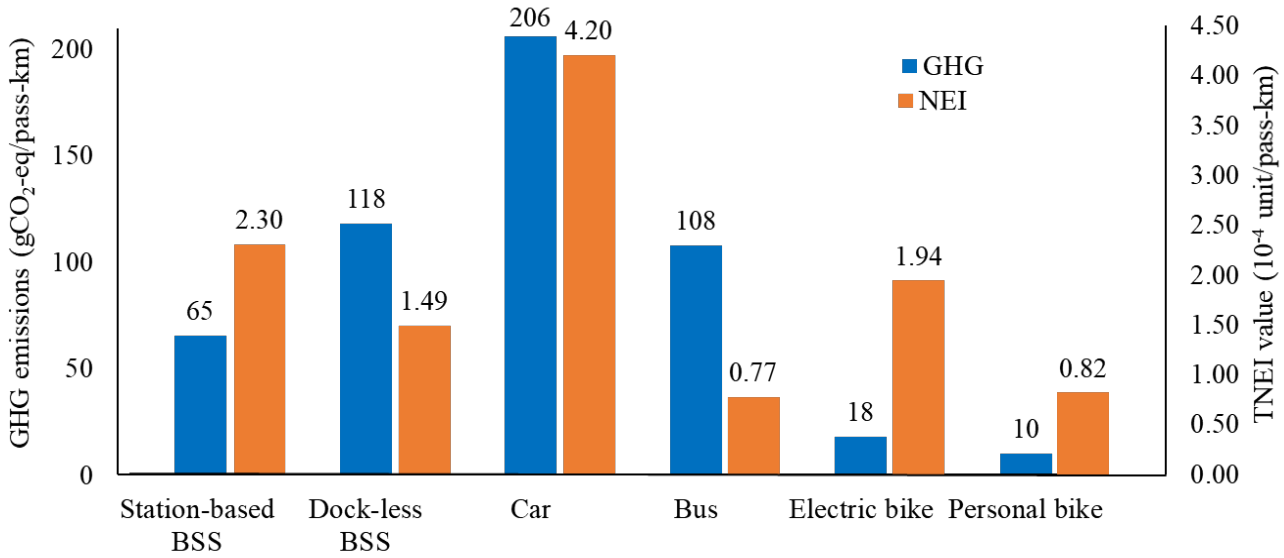




Bike share trips need to replace car trips to generate net emission reduction benefits

Q1: How do emission factors (g CO_2-eq/p-km) of bike share compare to other transportation modes?





- Dock-less system generally higher GHG emission factor
- Rebalancing is the key factor for both
- System-to-system variation is significant
- The emission factor of bike share trips could be as high as bus trips

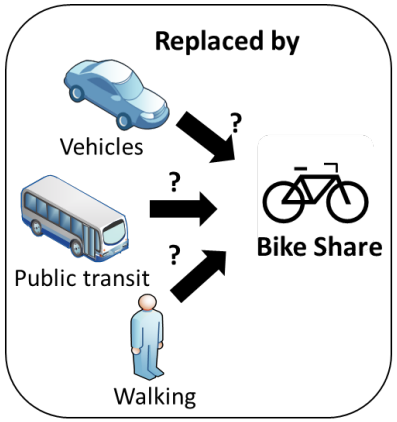
Luo, H., Kou, Z., Zhao, F., & Cai, H. (2019). Comparative life cycle assessment of station-based and dock-less bike sharing systems. *Resources, Conservation and Recycling*, *146*, 180-189.

Understanding mode replacement requires consideration of trip time, distance, and OD locations

Q2: What transportation modes do bike share trip replace and its contribution to GHG emission reduction? (station-based system)

Literature approaches (e.g., Zhang and Mi)2018) and Fishman et al. (2014):

- Simplified threshold (e.g., trips longer than 1km replace car)
- Survey based approach



what mode will you use if not using bike share?

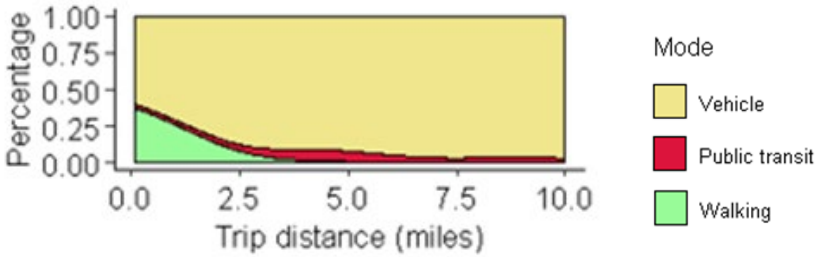
x% users reported replacing car

Benefits from replacing car trips
= total trip distance * emission factor * % replacing cars

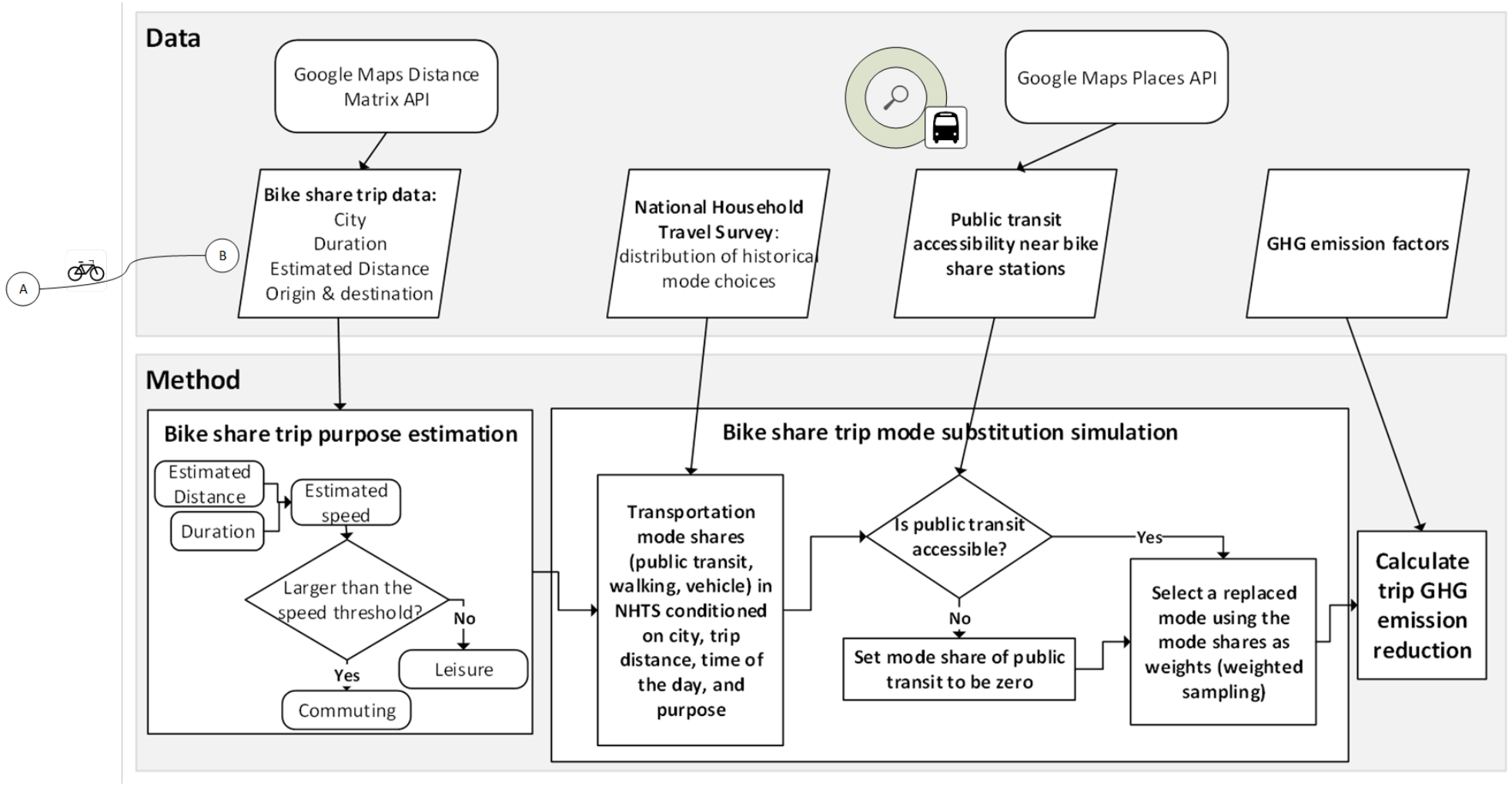
Limitations:
- % of users ≠ % of miles
- Ignored heterogeneous choices

Proposed approach (data-driven):

- Historical travel patterns
- Trip purpose (commuting and leisure)
- Trip time
- Public transit access

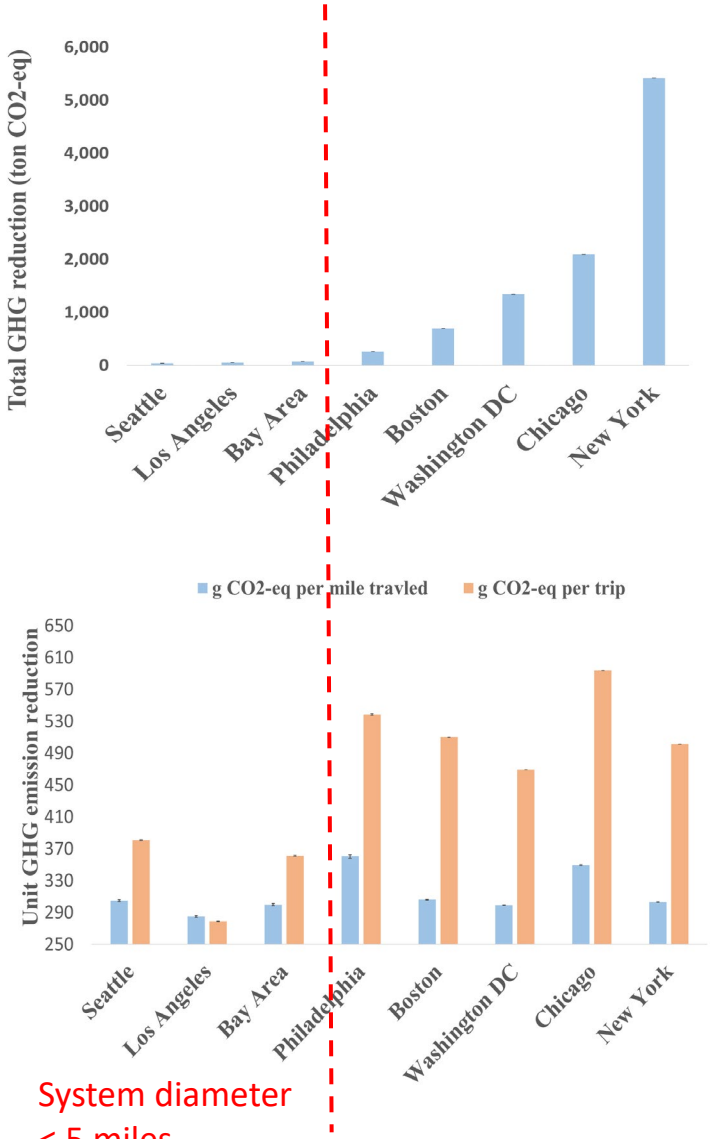


Bike Share Emission Reduction Estimation Model (BS-EREM)

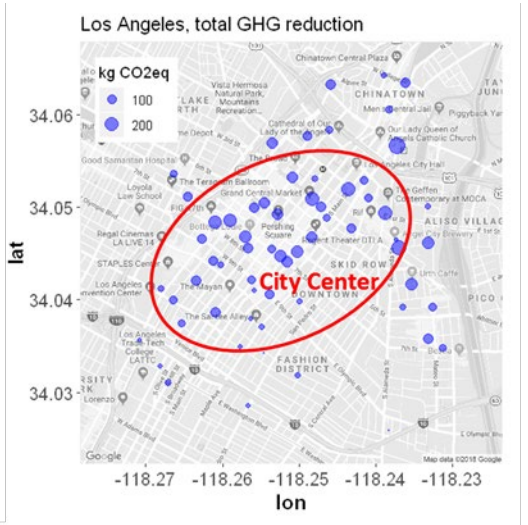


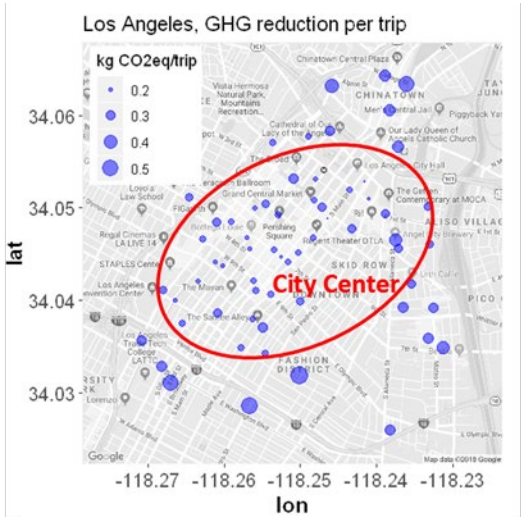
Kou, Z., Wang, X., Chiu, S. F. A., & Cai, H. (2020). Quantifying greenhouse gas emissions reduction from bike share systems: a model considering real-world trips and transportation mode choice patterns. *Resources, Conservation and Recycling*, 153, 104534.

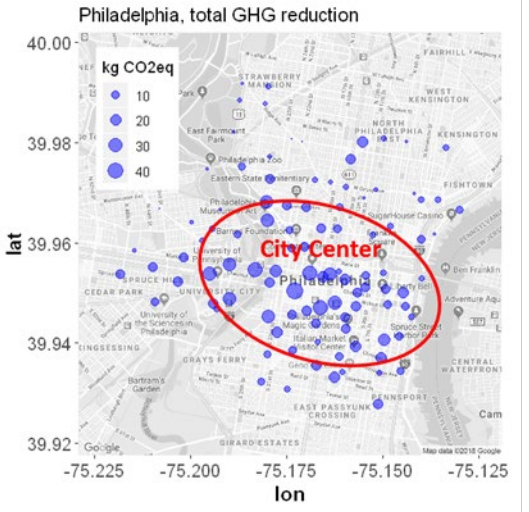
Larger systems and stations located in suburban areas help replace car use and reduce emissions

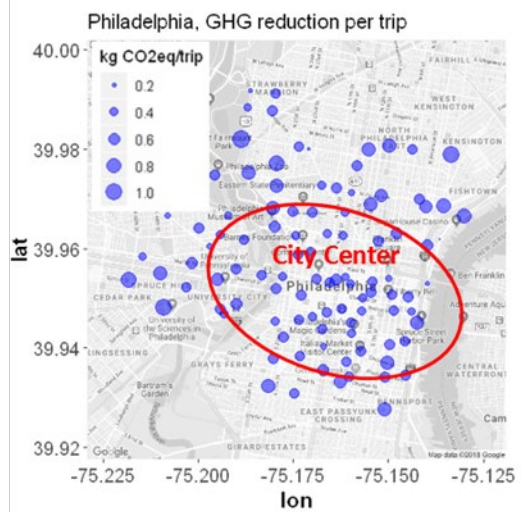


System diameter
< 5 miles



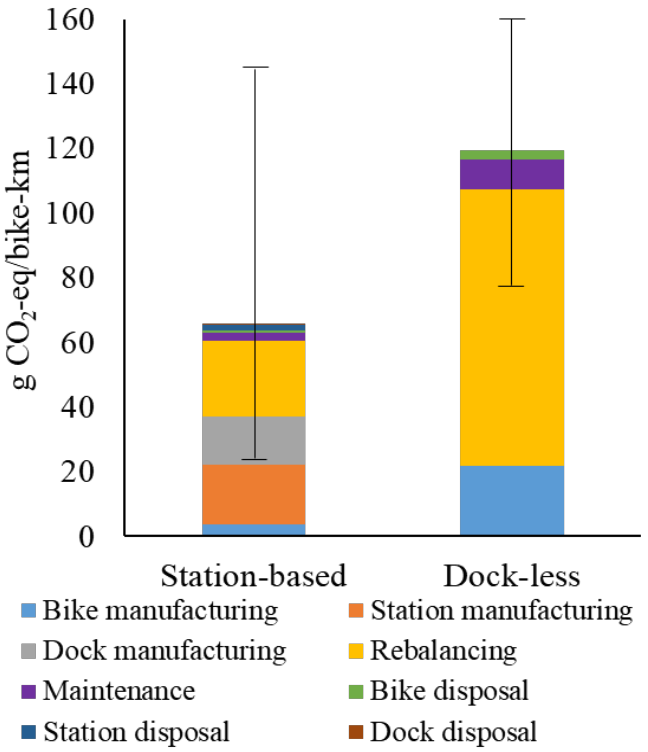






Key assumption: stable system and operation over 10 years

Bike share as an emerging system is still evolving



INDIANAPOLIS NEWS AND HEADLINES › INDIANAPOLIS LOCAL NEW

Pace bike share to leave Blo scooters move in

WRTV abc

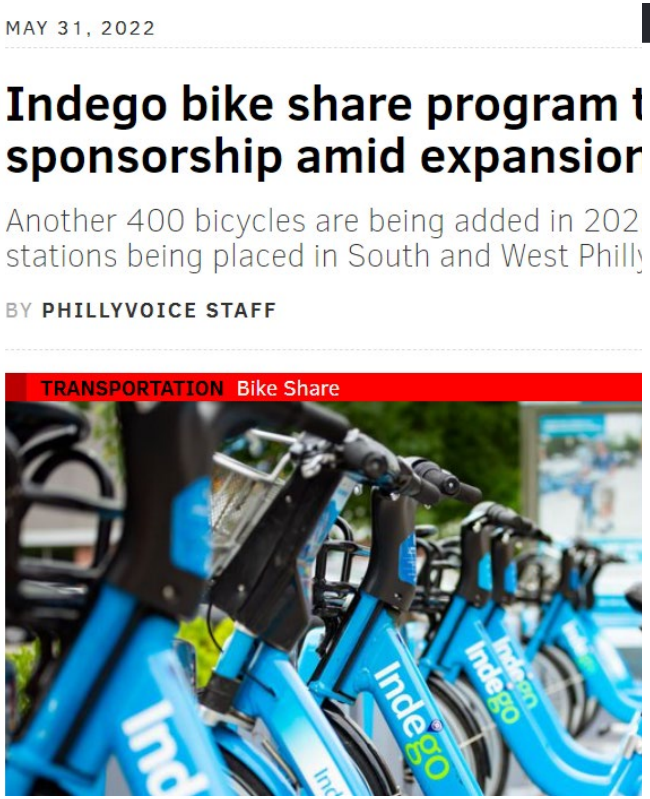
By: Andrew Smith

Posted at 9:39 AM, May 06, 2019 and last updated 9:44 AM, May 06, 2019

BLOOMINGTON — Pace, a bike sharing program in Bloomington, announced it will terminate their program in the city in the coming weeks.

The news of Pace leaving Bloomington comes just a little over a month after a third e-scooter company, Spin, got approval from the city to bri their scooters to the city.

On April 2, the city approved a interim operating agreement for Spin.



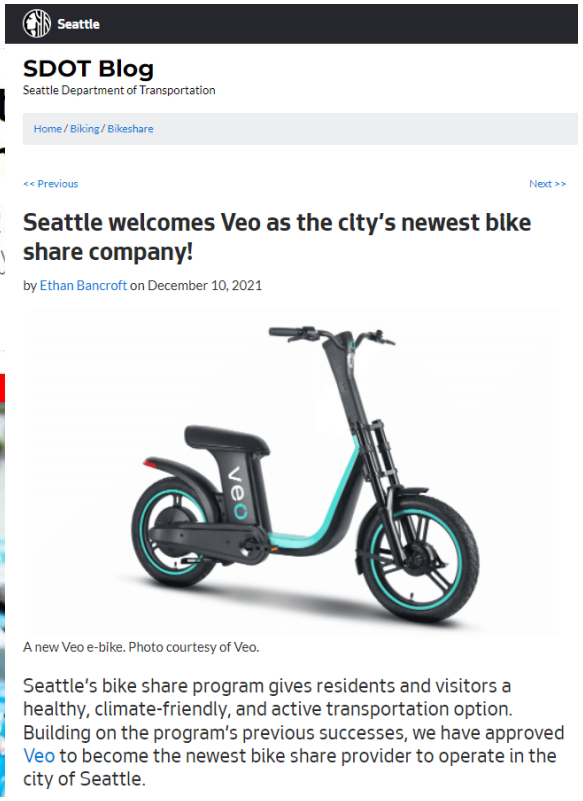
MAY 31, 2022

Indego bike share program t sponsorship amid expansior

Another 400 bicycles are being added in 202 stations being placed in South and West Philly

BY PHILLYVOICE STAFF

TRANSPORTATION Bike Share



Seattle

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Seattle welcomes Veo as the city's newest bike share company!

by Ethan Bancroft on December 10, 2021

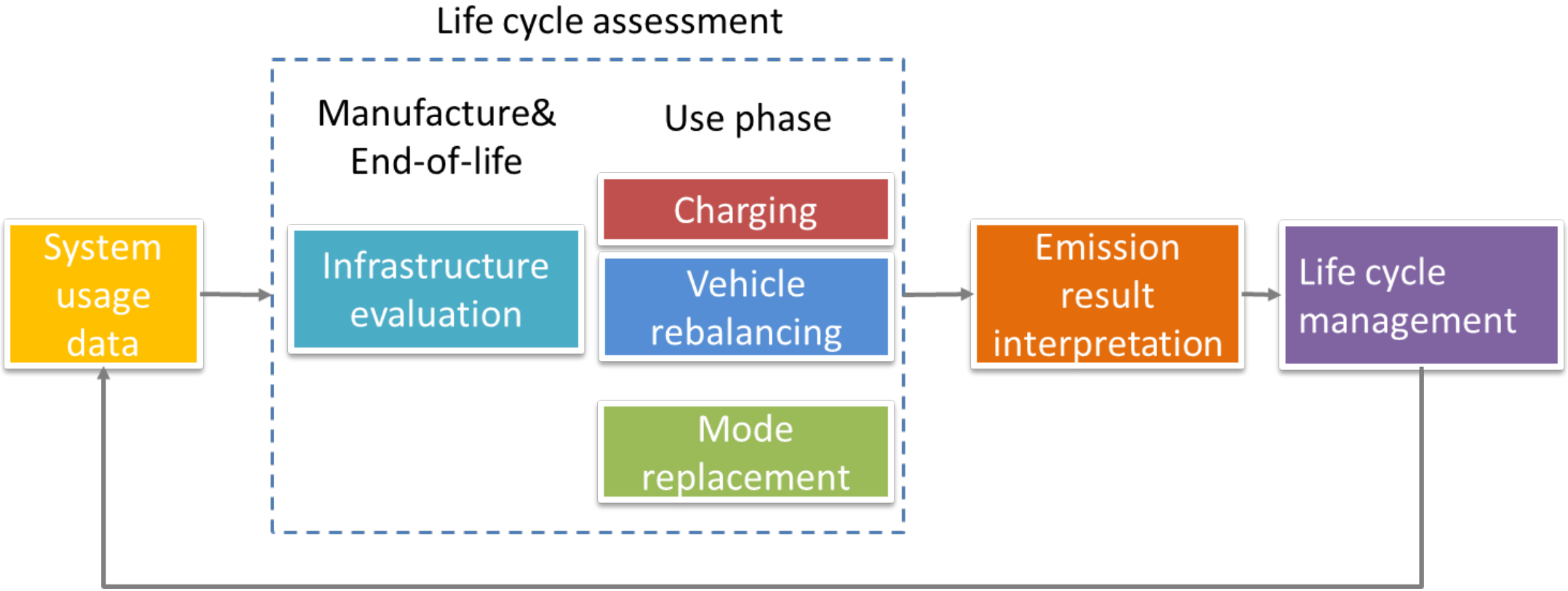
A new Veo e-bike. Photo courtesy of Veo.

Seattle's bike share program gives residents and visitors a healthy, climate-friendly, and active transportation option. Building on the program's previous successes, we have approved Veo to become the newest bike share provider to operate in the city of Seattle.

- System size and operation significantly varies
- System expansion and termination
- It takes time to "payback" the initial and expansion carbon emission "investment"

A city-specific dynamic LCA model to better assess and guide the development of sustainable bike share systems

Q3: When are the breakeven points for carbon emission reduction in different systems?



- City-specific vehicle rebalancing estimation
- Dynamic evaluation of carbon emission investment and reduction

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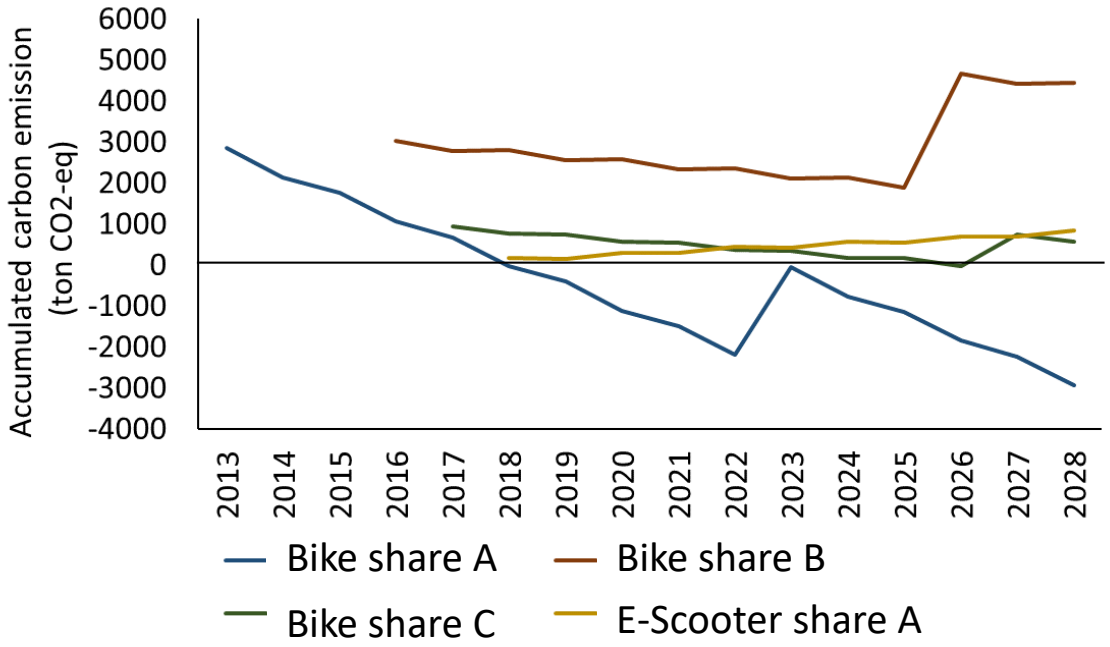
Preliminary results from four case study systems

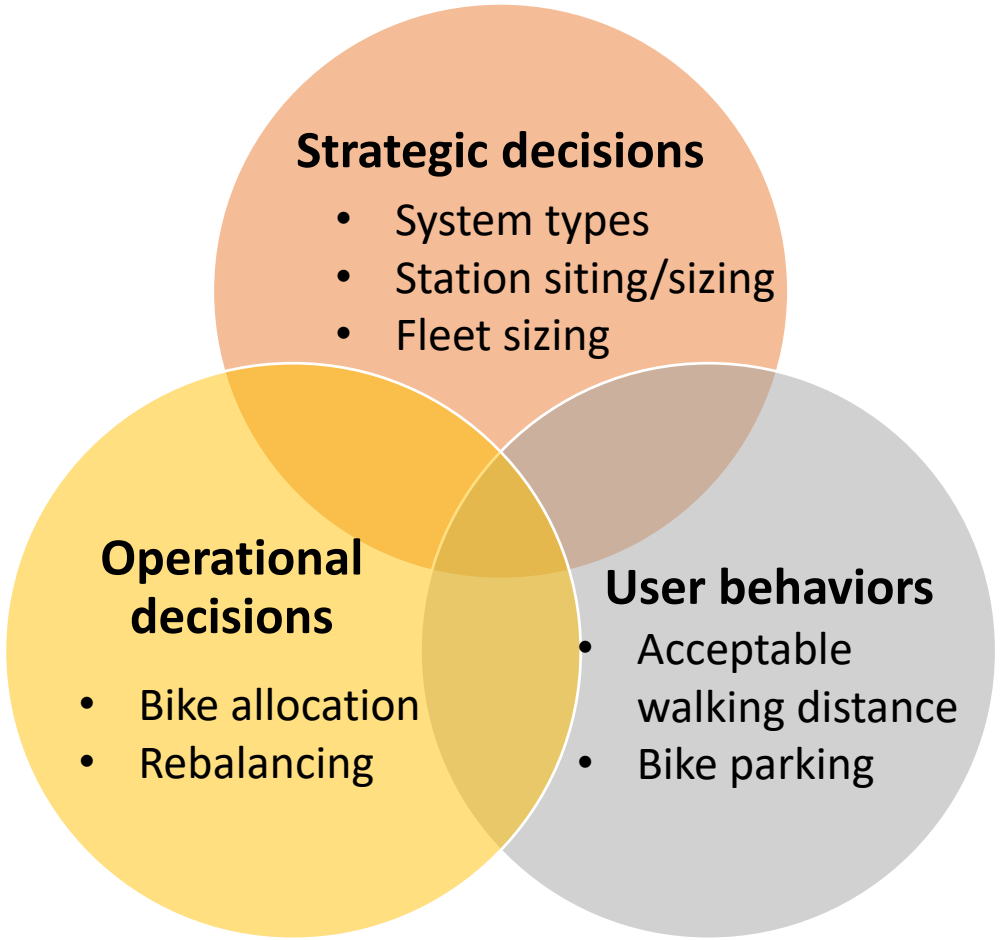
	Station-based bike share system A	Station-based bike share system B	Station-based bike share system C	Dock-less e-scooter system A
Year of operation	2013	2016	2017	2018
System coverage(km^2)	387	192	115	153
# Station	754	780	224	
# Dock	12337	14578	4017	
# Vehicle	6009	4900	2992	5235



- Not all shared micromobility systems are providing carbon emission reduction benefits
- It takes time to reach carbon emission "breakeven" – frequent program termination or change of vendors could lead to higher emissions
- Infrastructure life span, car trip replacement rate, and rebalancing efficiencies are key

Developing sustainable bike share system needs to consider system interactions

Improve existing systems can also consider system optimization, well planned expansion, and system type change



Stakeholders

Users
- Service level
- Excess time

Operators
- Cost / revenue
- Rebalance miles

City / Society
- Bikes parked on street
- Emission reduction

- Luo, H., Zhao, F., Chen, W. Q., & Cai, H. (2020). Optimizing bike sharing systems from the life cycle greenhouse gas emissions perspective. *Transportation Research Part C: Emerging Technologies*, *117*, 102705.
- Kou, Z., & Cai, H. (2021). Comparing the performance of different types of bike share systems. *Transportation research part D: transport and environment*, *94*, 102823.

Conclusions

Thank you!!
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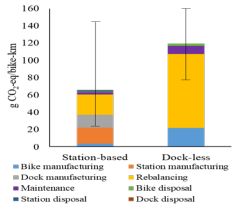
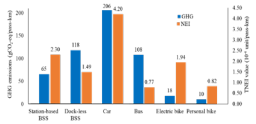
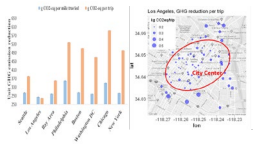


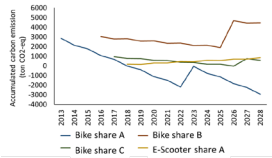
Rebalancing and infrastructure (station and docks) significantly contribute the life cycle GHG emission of a bike share system



Bike share trips need to reduce car trip to reduce transportation emissions



Larger system diameter and locating bikes in suburban regions help increase car-replacement trips



Not all shared micromobility systems are providing carbon emission reduction benefits.

The proposed models can also be applied to study shared e-scooters and e-bikes!